



# Improved accelerated breath-hold radial cine image reconstruction by acquiring additional free-breathing data between breath-holds

## Citation

Nam, Seunghoon, Mehmet Akcakaya, Yongjun Kwak, Beth Goddu, Kraig V Kissinger, Warren J Manning, Vahid Tarokh, and Reza Nezafat. 2012. Improved accelerated breath-hold radial cine image reconstruction by acquiring additional free-breathing data between breath-holds. *Journal of Cardiovascular Magnetic Resonance* 14(Suppl 1): P269.

## Published Version

doi:10.1186/1532-429X-14-S1-P269

## Permanent link

<http://nrs.harvard.edu/urn-3:HUL.InstRepos:11729588>

## Terms of Use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA>

## Share Your Story

The Harvard community has made this article openly available.  
Please share how this access benefits you. [Submit a story](#).

[Accessibility](#)

POSTER PRESENTATION

Open Access

# Improved accelerated breath-hold radial cine image reconstruction by acquiring additional free-breathing data between breath-holds

Seunghoon Nam<sup>1,3\*</sup>, Mehmet Akcakaya<sup>1</sup>, Yongjun Kwak<sup>1,3</sup>, Beth Goddu<sup>1</sup>, Kraig V Kissinger<sup>1</sup>, Warren J Manning<sup>1,2</sup>, Vahid Tarokh<sup>3</sup>, Reza Nezafat<sup>1</sup>

From 15th Annual SCMR Scientific Sessions  
Orlando, FL, USA. 2-5 February 2012

## Background

Evaluation of cardiac function is clinically performed using multi-slice breath-hold (BH) acquisition, in which patient breathes for a period of 40-60 seconds between a BH of 10-12 seconds. This results in suboptimal data acquisition efficiency. In this study, we propose to take advantage of the time between multiple BHs to acquire additional free-breathing (FB) data that can be used in the reconstruction of undersampled BH acquisition without increasing the total scan time.

## Methods

Figure 1 shows the proposed data acquisition strategy. An undersampled BH acquisition is followed by a fully-sampled FB acquisition during the resting period between BH acquisitions when the patients were instructed to breathe normally. The undersampled radial cine data were reconstructed using compressed sensing (CS) [1]. Each cardiac phase image was sparsified by subtracting the FB image with the same cardiac phase for successful CS reconstruction. Each cardiac phase image is reconstructed by an iterative CS algorithm which minimizes the objective function  $\|Am_i - y_i\|_2^2 + \lambda_1 \|\Psi m_i\|_1 + \lambda_2 \|m_i - m_{FB,i}\|_1$ , where  $m_i$  denotes the  $i$ -th cardiac phase image,  $y_i$  denotes the undersampled radial k-space measurement for  $i$ -th cardiac phase,  $A$  is the radial acquisition matrix,  $\Psi$  is a sparsifying transform matrix, and  $m_{FB,i}$  is the  $i$ -th cardiac phase image from the fully-sampled FB acquisitions. The fully-sampled FB images are reconstructed by gridding algorithm [2]. The data were acquired on 1.5T Philips scanner with ECG-

gated SSFP sequence using 5-channel cardiac-coil array. The following parameters were used: FOV=(320mm)<sup>2</sup>, spatial resolution=(1.7mm)<sup>2</sup>, TR/TE/ $\alpha$ =3.1/1.5/55°, temporal resolution=34ms. All BH and FB acquisitions were acquired fully-sampled, and the BH acquisition was retrospectively undersampled. Four FB data set were acquired for each BH dataset and averaged to get  $m_{FB,i}$ .

## Results

Figure 2 shows example cardiac phase images reconstructed by the proposed CS algorithm, conventional CS algorithm which utilizes  $x$ - $f$  space sparsity [3], and the gridding algorithm. The BH data was undersampled to have 33% and 20% of projections from fully-sampled data. The proposed method has less streaking artifacts, sharper blood-myocardium borders and improved image qualities.

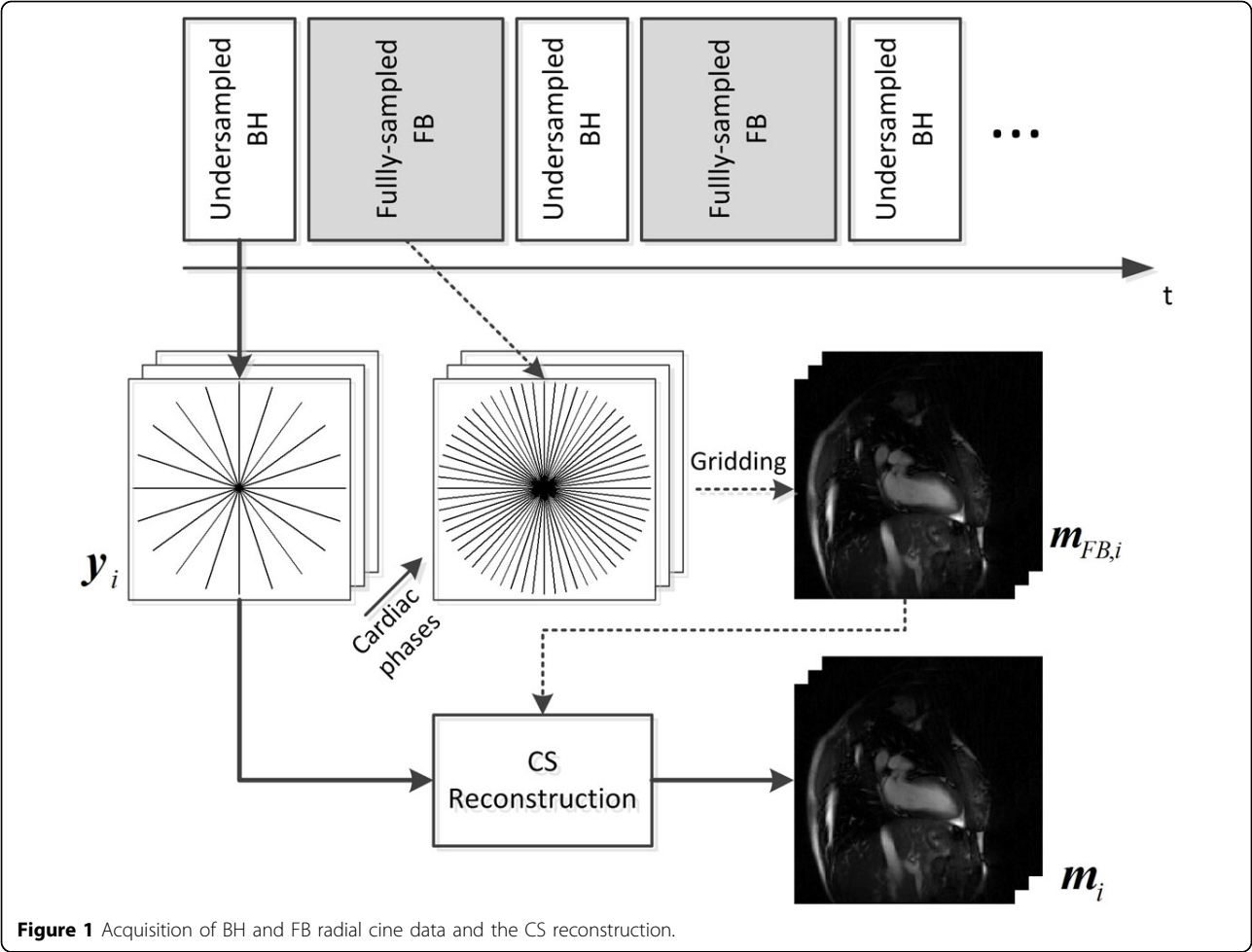
## Conclusions

We demonstrated the feasibility of CS reconstruction for undersampled radial cine imaging utilizing the FB data acquired during the resting period between BH acquisitions. The results show that the CS reconstruction improves the image quality and can be used either to reduce the BH duration or increase the spatio-temporal resolution of cine imaging. Further studies to evaluate global cardiac function in patients are needed to validate the clinical accuracy of the proposed technique.

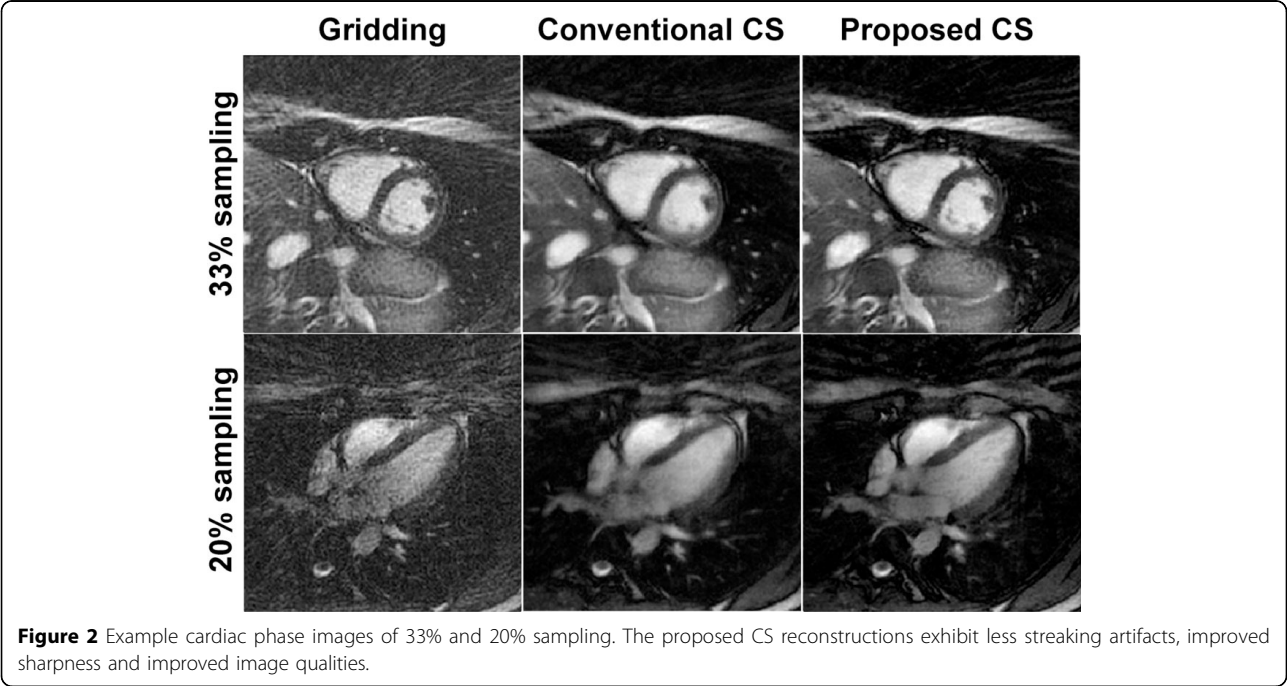
## Funding

NIH R01EB008743-01A2.

<sup>1</sup>Medicine, Beth Israel Deaconess Medical Center, Boston, MA, USA  
Full list of author information is available at the end of the article



**Figure 1** Acquisition of BH and FB radial cine data and the CS reconstruction.



**Figure 2** Example cardiac phase images of 33% and 20% sampling. The proposed CS reconstructions exhibit less streaking artifacts, improved sharpness and improved image qualities.

#### Author details

<sup>1</sup>Medicine, Beth Israel Deaconess Medical Center, Boston, MA, USA.

<sup>2</sup>Radiology, Beth Israel Deaconess Medical Center, Boston, MA, USA. <sup>3</sup>School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, USA.

Published: 1 February 2012

#### References

1. Lustig : *MRM*. 2007.
2. O'Sullivan : *IEEE TMI*. 1985.
3. Gamper : *MRM*. 2008.

doi:10.1186/1532-429X-14-S1-P269

**Cite this article as:** Nam *et al.*: Improved accelerated breath-hold radial cine image reconstruction by acquiring additional free-breathing data between breath-holds. *Journal of Cardiovascular Magnetic Resonance* 2012 **14**(Suppl 1):P269.

**Submit your next manuscript to BioMed Central  
and take full advantage of:**

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at  
[www.biomedcentral.com/submit](http://www.biomedcentral.com/submit)

